DISCUSSION DRAFT
NOT APPROVED BY THE DELTA STEWARDSHIP COUNCIL
SUBJECT TO CHANGE

DELTA PLAN AMENDMENTS FOR CONVEYANCE, STORAGE SYSTEMS, AND THE OPERATION OF BOTH

The Delta Stewardship Council (Council) is amending the Delta Plan to promote options for water conveyance[1], storage systems, and the operation of both as required by Water Code Section 85304. The draft Delta Plan amendment includes a suite of recommendations for Delta water management system operations and supporting infrastructure improvements that, together and in combination with existing Delta Plan policies and recommendations, will further the coequal goals. The draft Delta Plan amendment does not include any new regulations, and therefore it does not apply to a project's consistency with the Delta Plan under Water Code section 85225, or any appeal to the Council of a certification under Water Code sections 85225.5 et seq.

INTRODUCTION

The Sacramento-San Joaquin Delta (Delta) and California's water supply systems are in crisis,[2] and existing Delta water management practices are not sustainable.[3] The recent drought followed by record precipitation underscores this crisis.[4] For decades, human-produced alterations to the Delta's landscape and the operations of water management projects in the Delta and throughout the watershed have combined with multiple other factors to create stressors that imperil the Delta ecosystem and state-wide water supply reliability.[5]

During the mid-1900s when major conveyance and storage facilities of the State Water Project (SWP) and the Central Valley Project (CVP) were authorized and constructed, the State of California (State) was focused on expanding water supplies for economic growth to improve the quality of life throughout California. These projects achieved their purposes of increasing water supplies for agriculture and urban centers, but in doing so they markedly added to the changed physical and ecological conditions in the Delta and its watershed. Subsequently, during the 1970s and 1980s the values informing how we manage water and other natural resources have changed, and the mission of these and other major water storage and conveyance facilities expanded to address native species protection and the maintenance of water quality for human uses in the Delta.[6]

[1] "Conveyance" is defined in the Delta Plan as the movement of water from one place to another. Conveyance infrastructure includes natural watercourses as well as canals, pipelines, and control structures including weirs. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.
[2] Nichols et al. 1986; Service 2007; Moyle et al. 2013, 2016; Moyle 2014; Luoma et al. 2015
[3] Lund, 2016
[4] Medellín-Azuara et al. 2015; Lund 2016
[5] Hanak et al. 2013; Mount et al. 2012
[6] Lund et al. 2007

The prolonged drought of 1987-1992 highlighted more than any previous experience the sensitivity of the Delta ecosystem to environmental stressors and the linkage to long-term stability of Delta exports.[7] The 1994 Bay-Delta Accord was an historic milestone that brought the State and federal governments together to develop and implement a vision to reverse the declining health of the Delta ecosystem. Subsequent years of study and stakeholder involvement during the CALFED Bay Delta Program resulted in a clearer vision for the future and presaged the need for integrated conveyance and storage and the need to achieve the coequal goals that became the foundation of the 2009 Delta Reform Act and the Delta Plan. Despite changes in water system operations and management, ecosystem health has continued to decline in the Delta.[8]

Today, our existing and planned conveyance and storage projects must be operated to meet multiple objectives. The 2009 Delta Reform Act signaled a resolve by the State to implement solutions that would achieve the coequal goals.

> *Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.* –Water Code section 85054

The Delta Plan includes a portfolio of policies and recommendations intended to build regional water supply reliability; reduce reliance on the Delta; improve the Delta's ability to support viable populations of native resident and migratory species and to protect and restore habitats for these species; promote statewide water conservation and water use efficiency and sustainability; and improve water quality to protect human health and meet drinking water needs. The Plan also seeks to protect and enhance the unique characteristics of the Delta as an evolving place.

However, our current water management system, as constructed and operated today, is not capable of achieving the Delta Plan's coequal goals.[9] In particular, the use of existing south Delta intake facilities as the sole point of diversion for two large water conveyance systems – the SWP and the CVP – continues to result in entrainment[10] of native fish and changes to water

[7] The Delta Plan defines "Delta exports", in general terms, as any water diverted from the Delta for use outside the Delta, including water pumped by the State Water Project and Central Valley Project pumping plants, Contra Costa Water District, and other agencies. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.
[8] Cloern et al. 2012
[9] The Delta Plan, Delta Stewardship Council, 2013, as amended, Chapter 3.
[10] Defined by the National Marine Fisheries Service as "the incidental trapping of any life stage of fish within waterways or structures that carry water being diverted for anthropogenic use." See also Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.

quality and Delta food webs, posing fundamental challenges to improving ecosystem health and providing better water management.[11]

Continuation of the status quo in the Delta is not sustainable with respect to ecosystem health or water supply reliability. The state's most recent drought resulted in severe impacts to listed fish species and a precipitous decline in the delta smelt population. Concurrently, historically low contract allocations and water exports via SWP and CVP facilities caused severe water shortages to some urban and agricultural areas. The drought also triggered the first ever imposition of state-wide emergency water conservation regulations. The experience and impacts of this recent five-year drought, the second multiyear near state-wide drought in less than ten years, underscores the state's and the Delta's vulnerability if we simply maintain the status quo. It also illustrates the pressing need to implement solutions to achieve the coequal goals.

The current decline of aquatic resources in the Delta and the erosion of water supply reliability will continue as the state's changing climate places additional stressors on ecosystem and water management. Extended, intense droughts and more extreme floods are expected to occur more frequently in the future due to climate change.[12] Since 2007, California has experienced nine years of below average runoff and only two years out of eleven have had precipitation amounts above the long-term average. As noted above, California's recent five-year drought has reinforced our understanding of the harmful effects of sustained dry periods on ecosystem health and the correlation between Delta exports and overall State water supply reliability.[13] In stark contrast, historically high combined rainfall and snowpack in late 2016 and early 2017 has called to question the capacity of flood management systems to accommodate future precipitation extremes. Water management and ecosystem sustainability strategies must recognize these climatic trends and work to improve system robustness and resiliency.[14,15]

The experience of two prolonged droughts in the last ten years has also reinforced the need to implement a comprehensive strategy that increases the diversity of regional water supply portfolios, creates more sustainably managed local water sources, and achieves greater water use efficiency.[16] The benefits of water storage during an extended drought were also demonstrated, as were the detriments to water supply reliability, ecosystem health, and

[11] Mount et al. 2012
[12] Mann et al. 2017; Das et al. 2013; Pierce et al. 2013; Berg and Hall 2015; Cook et al. 2015; Differbaugh et al. 2015; Savtchenko et al. 2015; Stewart et al. 2015; Williams et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017
[13] Hanak et al. 2015; Medellín-Azuara et al. 2015; Chang and Bonnette 2016; Lund 2016; Moyle et al. 2016
[14] Jenkins et al. 2004; Opperman et al. 2009; Cahill and Lund 2013; Kiparsky et al. 2014; Null et al. 2014; Lund 2015; Dettinger et al. 2015; Dettinger et al. 2016b
[15] "Resilience" is defined in the California Water Plan as the capacity of a resource or natural system to adapt to and recover from changed conditions after a disturbance (DWR 2013).
[16] Aghakouchak et al. 2014; Ayars 2013; Cahill and Lund 2013; Null et al. 2014; Bachand et al. 2016; Elias et al. 2016; Fournier et al. 2016; Hanak et al. 2017

groundwater levels when storage is not adequate or is ineffectively managed.[17] Further, the Sustainable Groundwater Management Act (SGMA) has prioritized the need to address severe overdraft of groundwater basins in many areas of California. There is an urgent need to conjunctively manage surface water and groundwater supplies as part of a comprehensive approach to statewide water management, and support the recovery of critically overdrafted basins.[18]

Conveyance, system storage, and operations are part of a broad and integrated portfolio of actions described in the Delta Plan. They are water management tools that are inextricably linked to the management of habitat conditions given the variable nature of the state's water supplies. Deploying one tool independent of the others is ineffective. It is only through the combination of new and improved Delta conveyance, the effective management of existing and expanded surface water and groundwater storage, and the balanced operations of both – combined with other actions and recommendations contained in the Delta Plan – that we can achieve the coequal goals.

The California Water Action Plan[19] lays out decisive actions needed to meet three broad objectives: developing more reliable water supplies, restoring important species and habitats, and providing a more resilient, sustainably managed water resources system (water supply, water quality, flood protection, and environment) that can withstand anticipated and unforeseen pressures in the coming decades. The plan further highlights the need for adaptive management in operating water facilities and in implementing conservation actions, particularly during drought. Action is required throughout California, but the Delta's central role in water management for many regions and citizens of the state makes success in Delta foundational to overall success. The comprehensive actions in the California Water Action Plan include:

- Make conservation a California way of life
- Increase regional self-reliance and integrated water management across all levels of government
- Achieve the coequal goals for the Delta
- Protect and restore important ecosystems
- Manage and prepare for dry periods
- Expand water storage capacity and improve groundwater management
- Provide safe water for all communities
- Increase flood protection

[17] U.S. Department of Interior, Bureau of Reclamation (Reclamation) 2015
[18] Jenkins et al. 2004; Castle et al. 2014; Lund 2016; Pulido-Velazquez et al. 2016
[19] California Natural Resources Agency et al., 2014; http://resources.ca.gov/california_water_action_plan/

- Increase operational and regulatory efficiency
- Identify sustainable and integrated financing opportunities.

Fortunately, California has taken several steps to implement these actions, as described in the California Water Action Plan 2016 Update.[20]

AMENDING THE DELTA PLAN

To achieve the coequal goals, there is a need to change the way water is managed and water systems are operated in the Delta. Maintaining the status quo will make achieving the coequal goals impossible in the future, and poses a significant risk of continued habitat and species decline and uncertainty in water supplies exported from the Delta. The magnitude of operational changes needed to achieve the coequal goals will not be possible without new investments in water infrastructure, namely improvements to water conveyance and storage facilities. Further, operational and infrastructure improvements need to progress together and in coordination with other actions identified in the Delta Plan, such as those related to restoring and enhancing the Delta ecosystem (Chapter 4), improving water quality (Chapter 6), achieving greater regional self-reliance and reduced reliance on the Delta (Chapter 3 and Appendix G), and reducing risks to people and property (Chapter 7).

There is no single solution to water management in California, as a whole, and in the Delta in particular.[21] Rather, a combination of near-term and long-term improvements to water conveyance, system storage, and operations are needed.[22] These improvements should seek to balance what can often be competing operational objectives (e.g., protecting threatened fish species and providing reliable water supplies) while minimizing conflicts and protecting the Delta's unique values. Further, as our knowledge of the Delta ecosystem continues to grow there remains significant uncertainty over the effectiveness of planned actions to protect, restore, and enhance the Delta. Consequently, adaptive management consistent with the framework outlined in the Delta Plan is critical for all actions that seek to further the coequal goals.[23]

Conveyance improvements in the Delta are needed so that water supplies can be safely moved when they are available and conflicts between water supply deliveries and species protection can be avoided. This will allow exports to be reduced in dry periods when aquatic ecosystem needs are magnified, and promote more effective use of surface and groundwater storage to

[20] California Natural Resources Agency et al. 2016; http://resources.ca.gov/california_water_action_plan/
[21] Luoma et al. 2015
[22] Hanak et al. 2017
[23] Water Code section 85052 defines adaptive management as a framework and flexible decision making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives. See also Appendix C of the Delta Plan (Delta Stewardship Council, 2013, as amended).

carry over supplies from wet to dry periods. Conveyance improvements outside the Delta are also needed to better leverage periods when conflicts between water exports and species protection are reduced, such that exported supplies can be managed conjunctively with local surface and groundwater supplies and storage facilities.[24]

Improved water storage in both surface reservoirs and groundwater is needed to accommodate changing hydrology throughout the Delta watershed, to better achieve the beneficial functions of more natural and variable flows, to maintain better temperature conditions in the Delta and its tributaries, to allow the storage of water supplies for later use during dry periods, and to sustainably manage the state's aquifers. Moreover, improvements to conveyance and storage must be operated in an integrated manner[25] that furthers achievement of the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. Throughout California, water managers are actively pursuing opportunities to implement integrated strategies and improvements to water conveyance, system storage, and the operations of both to achieve local and regional goals.

At this juncture, the Council, based on historical information and the best currently available science[26], is proposing to amend the Delta Plan to promote options for water conveyance, storage systems, and the operation of both as required by Water Code Section 85304. Many options have been discussed, proposed, and evaluated by various parties over the past decades, and many options have been implemented. The recommendations in this draft are a proposal for amending the Delta Plan, and are based upon the *19 Principles for Water Conveyance in the Delta, Storage Systems, and for the Operation of Both to Achieve the Coequal Goals*[27] adopted by the Delta Stewardship Council in November 2015 and input from Council members and the public. The draft amendment describes the types and characteristics of infrastructure that would contribute to the achievement of the coequal goals, and also identifies recommended criteria for project proponents to use in evaluating and developing new conveyance and storage projects. The amendment does not prescribe the construction or implementation of specific projects or project proposals, nor does it describe the specific size, location, or configuration of such projects.

This amendment is proposed to be included as part of the Delta Plan that was originally adopted by the Council in May 2013. It is intended to work together with existing Delta Plan recommendations and regulatory policies that reduce risk and protect water quality, high-priority habitat areas, Delta as a Place values, reduced reliance on the Delta, and more. The Delta Plan includes a portfolio of strategies to achieve the coequal goals, and this amendment adds to this portfolio by promoting improvements to water conveyance, storage systems, and the operation

[24] Hanak et al. 2017
[25] Null et al. 2014
[26] "Best available science" means the best scientific information and data for informing management and policy decisions (23 California Code of Regulations Section 5001).
[27] http://deltacouncil.ca.gov/docs/19-principles-water-conveyance-delta-storage-systems-and-operation-both-achieve-coequal-goals

of both. This draft amendment should be read in tandem with the Delta Plan, including Delta Plan requirements to reduce reliance on the Delta and increase regional self-reliance (see regulatory policy WR P1 and recommendations WR R4 and WR R18), and with the Delta Plan's guidance regarding more natural, functional flows for the ecosystem (see regulatory policy ER P1, recommendation ER R1, and page 134 of Chapter 4).

Many agencies, boards, districts, commissions, and other entities are engaged in managing the Delta at federal, State, regional and local levels. Consequently, the recommendations in this draft interact with the planning, implementation, and/or regulatory activities of many entities. Their roles, responsibilities, and missions vary significantly, and none bear sole responsibility for taking action to achieve the coequal goals. Some of the recommendations included in this draft amendment pertain to project proponents who are implementing projects related to conveyance, storage, and their operations, while others pertain to agencies with planning or regulatory review responsibilities. The Council appreciates that agencies with regulatory responsibilities, such as the State Water Resources Control Board and local governments, will have an important role in the review and approval of the actions recommended in this draft amendment. An important function of the Council is to foster collaboration and coordination among the many entities engaged in projects or planning in the Delta to support decision making that will further the coequal goals.

PROBLEM STATEMENT

Californians have long adapted to the state's highly variable hydrology, characterized by sustained long-term droughts and occasional massive floods.[28] In fact, the state has the most variable annual precipitation patterns of any state within the United States.[29] The existing State and federal water systems were designed principally to address the state's geographic imbalance between abundant, seasonal water supplies north of the Delta, and emerging agricultural, municipal and industrial water demands to the south.[30] In these systems, Delta channels work in combination with water management infrastructure both inside and outside the Delta, including reservoirs, water intakes, pumping facilities, pipelines, and canals. However, much of this infrastructure is aging and vulnerable to natural hazards, and planned components of the State and federal systems were never completed.[31] Recent events have also highlighted the need to inspect and adequately maintain water infrastructure, and ensure adequate long-term funding for ongoing inspections and maintenance.

[28] Dettinger and Ingram 2013; Dettinger 2016a
[29] Dettinger et al. 2011
[30] Barnes and Chung 1986; Reclamation 2008
[31] Lund et al. 2007

Today, demands on water infrastructure have fundamentally changed[32] as California's population and diversified economy has grown, societal values informing how we manage water and other natural resources have evolved, our climate is changing, and water needs have increased. In addition, populations of several endangered and threatened fish species have declined drastically since the construction of the State and federal water systems and other infrastructure in the Delta watershed. The declines are due to multiple factors, including: entrainment, changes to natural flow regimes[33] and flow direction, water exports (particularly in dry years), disconnection of rivers and streams from adjacent lands resulting from levee construction and channelization, habitat loss and alteration, urbanization, a warming climate, food availability, predation, and invasive species.[34] Among these many factors, CVP and SWP diversions represent one of the most directly observable sources of fish mortality.[35] Consequently, our water management systems are now called upon to meet ecosystem needs not envisioned when they were originally built in an increasingly complex regulatory environment.[36]

This conflict came to a crisis point in 2007 when a federal court significantly curtailed water deliveries south of the Delta to protect delta smelt. This launched a seven-year process in the federal courts examining the balance between fish protection requirements under the Endangered Species Act and water operations. Differing federal court orders ensued, some of which protected native fish and restricted water exports, while others recognized urban and agricultural water needs and ordered increased water exports. This period of litigation and court ordered operations of the water projects highlighted the difficulty in resolving this conflict under the status quo system of water conveyance. Reviews by federal and State wildlife agencies have shown that maintaining status quo conditions will likely result in further deterioration of threatened and endangered fish populations, which will necessitate additional restrictions on water supply exports.[37] If not addressed, this trend may be irreversible and make the achievement of the coequal goals infeasible.

Delta Ecosystem Decline

Human activities and their associated effects on land and water management over the last century and a half have irrevocably changed California's aquatic ecosystems. This is profoundly

[32] Lund 2016
[33] Flow regime refers to the regulation of ecological processes in river ecosystems, including the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (see Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended). In the Delta, seasonal and diurnal flow patterns (flow hydrograph) have been altered by upstream water diversions and reservoir operations, Delta water exports (especially during dry periods), and physical changes to the Delta (channelization, sedimentation, and land use changes). Changes to flow regime have directly affected habitat conditions – including habitat diversity, quality, and extent – and proven harmful to native species. Sources: Bunn and Arthington (2002), Petts (2009), SWRCB (2010).
[34] Healey et al. 2016; Mount et al. 2012
[35] Grimaldo et al. 2009
[36] Reclamation 1992
[37] National Marine Fisheries Service (NMFS) 2009; NMFS 2014; U.S, Fish and Wildlife Service 2009

evident in the Delta, where natural flow patterns have been altered and water has been confined to canalized channels where shallow wetlands once existed.[38] Under the existing configuration for water export, which features single, adjacent points of water diversion in the south Delta for both the SWP and CVP, operations result in direct fish losses at the pumps, change the way water and fish move through the Delta, create harmful reverse flow conditions, and place fish at greater risk of predation.[39] These effects have been compounded by the influx of invasive non-native species and changes to habitat quality and quantity upstream from the Delta. The result has been a dramatic decline in native species, including some aquatic species now on the brink of extinction. Despite recent restoration efforts and investments, aquatic species continue to decline.[40] These species also remain highly vulnerable to changing hydrologic conditions such as warmer water temperatures, longer water residence time, increased water clarity, and reduced flow. Further, significant uncertainty exists regarding the effects of projected climate on the hydrology of the Delta watershed and its ecological health.

Water temperatures have warmed and water quality in the Delta has changed over time, as was particularly evident during California's recent drought. Water quality degradation affects not only the Delta ecosystem, but also the ability of waterways to support sustainable agriculture, recreation, and other quality of life amenities for residents and local communities. Water dedicated to the environment, including storage reserved for water temperature and flow management in the Delta and its tributaries, will become increasingly important over the coming century.[41]

Conflicting Operational Priorities

A fundamental conflict exists today between water operations for ecosystem management (temperature and flow), water quality (both in-Delta and for water exported from the Delta), and water supply reliability. This conflict is magnified during critically dry periods and periods of lower flow when the ecosystem is under increased stress and water suppliers are most vulnerable to shortages. Conflicts in the use and timing of water movement through the Delta for multiple purposes could be more easily addressed by improved water conveyance and storage infrastructure with greater capacity and operational flexibility, combined with investments in regional self-reliance as cited throughout the Delta Plan. This includes increased capacity to safely convey water through the Delta during wetter periods such that exports can be curtailed when fish are at risk, and expanded water storage capacity throughout the state to manage Delta flows and water temperature, and carry over water supplies from wet periods for use in dry periods. Additional storage and conveyance capacity would provide the flexibility needed to adapt to dynamic future conditions and our revolving understanding of ecosystem needs.

[38] Whipple et al. 2012
[39] NMFS 2014; Castillo et al. 2012; Gingras 1997
[40] Moyle et al. 2010, NMFS 2014
[41] Hanak et al. 2012

An example of this conflict relates to degraded water quality in the Delta during periods of lower flow, which impacts the treatability of water for municipal and industrial uses and creates public health concerns that often must be addressed through higher-cost water treatment processes. Water quality for exports can be improved by moving diversion locations, but doing so also has the potential to degrade water quality for in-Delta uses. These impacts must be carefully monitored and mitigated. Improving, monitoring, and adaptively managing the operation of water systems in the Delta would augment our capacity to balance these priorities and further achievement of the coequal goals.

Changing Conditions

Conflicting priorities in water and ecosystem management will be intensified by climate change, which will alter the magnitude, timing, duration, frequency, and rate of change of stream flows in the Delta watershed.[42,43] Climate change will result in higher ambient temperatures, reduced Sierra Nevada snowpack, more precipitation falling as rain rather than snow, snow melting earlier and more rapidly, warmer stream temperatures, and higher amounts of water loss through evapotranspiration.[44] Climate change is also expected to trend toward more frequent and extended periods of drought as well as more frequent and intense floods.[45]

Climate change will also contribute to rising sea levels along California's coast and within its estuaries.[46] Rising sea levels will place additional burdens on the water management system in the Delta in the years to come.[47] Through-Delta conveyance is very likely to experience salinity increases with sea level rise, which will ultimately rise above appropriate concentrations for drinking water and irrigation in some areas of the western Delta if freshwater outflows are not increased.[48] It is projected that salinity at Jersey Point could increase by 23% in the early 21st century (2012-2040) and 88% by the end of the century, assuming an estimated mean sea level rise of 36 inches (92 centimeters (cm)).[49] For the SWP and CVP, a projected 11.8 inches (30 cm) rise in sea level by the mid-21st century would raise salinity enough to reduce by 10% the amount of time that the projects can operate.[50] Reservoir releases to repel salinity are expected

[42] Anderson et al. 2008; Huang et al. 2012; Berghuijs et al. 2014; Goulden and Bales 2014; Van Lienden et al. 2014; Savtchenko et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017

[43] "Climate change" is defined in the Delta Plan as any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from (1) natural factors, including changes in the sun's intensity or the Earth's orbit around the sun, (2) natural processes within the climate system, or (3) human activities that change the composition of the atmosphere. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.

[44] Anderson et al. 2008; Huang et al. 2012; Berghuijs et al. 2014; Goulden and Bales 2014; Van Lienden et al. 2014; Savtchenko et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017; Ficklin et al. 2013

[45] Das et al. 2013; Pierce and Cayan 2013; Pierce et al. 2013; Seager et al. 2013; Berg and Hall 2015; Cook et al. 2015; Differbaugh et al. 2015; Stewart et al. 2015; Walton et al. 2017

[46] Griggs et al. 2017

[47] Cayan et al. 2008; National Research Council 2012; Van Lienden et al. 2014

[48] Fleenor and Bombardelli 2013

[49] Van Lienden et al. 2014

[50] Anderson et al. 2008

to reduce Delta water exports by about 10% by 2050 and by about 25% by 2100.[51] In other words, a 1-foot (30 cm) rise in sea level would require almost 500,000 acre-feet of additional Delta outflow to meet current Delta salinity requirements.[37] With sea level rise and increasing temperatures, new and expanded water storage will play a critical role in providing adequate flows in the Delta to manage water flow and water quality (salinity) for all uses.

In addition, California's population is expected to increase from about 39 million in 2016 to more than 44 million by 2030.[52] Population growth and increased economic activity, in combination with land-use changes, economically-driven grower choices that favor permanent crops, and demand hardening from advances in conservation and water use efficiency, will alter water demand patterns.[53] Continued progress in urban conservation is likely to substantially offset demand increases due to population growth, and agricultural water demand is expected to decrease over time. Environmental water demands[54], however, are expected to increase in the coming years.[55] All of these factors will place stress on the existing system of conveyance and storage in the state. This creates a much more difficult situation in which to maintain a healthy Delta ecosystem while providing reliable water supplies.

Sustainable Groundwater Management

Many areas of California rely on groundwater for all or a portion of their water supplies.[56] As demonstrated during California's recent drought, heavy reliance on groundwater can lead to groundwater overdraft[57], subsidence due to falling groundwater levels, and loss of access to groundwater in some communities. Extraction of groundwater in the Central Valley region, in particular, has reduced both the groundwater level and underground storage capacity due to subsidence.[58] Groundwater pumping in the Central Valley during the drought was estimated to be about five million acre-feet (MAF) in 2014 and about six MAF in 2015.[59] Conjunctive management of surface and groundwater supplies, including passive and active groundwater recharge and in-lieu recharge[60], is an important tool for sustainable groundwater management.[61] Recent estimates of water available for replenishment of groundwater demonstrate that some

[51] Dettinger. 2016a
[52] California Department of Finance 2016
[53] Kiparsky et al. 2014; Bauer et al. 2015; Dettinger et al. 2015; Wilson et al. 2016
[54] "Environmental water" use is defined in the Delta Plan as Water dedicated to instream environmental needs. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.
[55] Hanak et al. 2012
[56] State Water Resources Control Board (SWRCB) 2015
[57] "Groundwater overdraft" is defined in the Delta Plan as The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.
[58] Famiglietti et al. 2011; Weiler 2014
[59] Howitt et al. 2015
[60] "In-lieu recharge" is the process of temporarily decreasing the amount of groundwater pumped from an aquifer in combination with a proportional increase in surface water deliveries. Decreased groundwater pumping typically occurs in wet years, allowing the aquifer to naturally recharge and be available for use during dry years.
[61] Fournier et al. 2016

surface water may be available for replenishment in each of the state's hydrologic regions and many of the planning areas, especially during relatively high flow events.[62] Improvements to conveyance, system storage, and the operations of both can support conjunctive management and contribute to sustainable groundwater management in many areas of the state.

Delta Water Quality and Human Right to Water

The Delta Plan must "promote statewide water conservation, water use efficiency, and sustainable use of water"[63] and include measures to promote a more reliable water supply by meeting water needs, sustaining the economic vitality of the state, and improving water quality to protect human health. The Council must consider incorporating actions in the Delta Plan to implement specific subgoals and strategies, including improving water quality to meet drinking water goals. These requirements relate closely to California's policy in Water Code Section 106.3 that "every human being has the right to, safe, clean, affordable, and accessible water adequate for human consumption, cooking and sanitary purposes." The Delta Plan acknowledges that the Council must consider this policy. In addition, the eight inherent objectives for management of the Delta include protecting and enhancing the Delta as an evolving place. This goal indicates that the evolving needs of the people who rely on the Delta must be considered.

The human right to water extends to all Californians, including disadvantaged individuals and groups, and communities in rural and urban areas. Disadvantaged communities are disproportionately affected by water resource challenges related to groundwater, as many small and rural communities rely on groundwater for all or a large portion of their supplies.[64] Further, many small and rural communities rely on impaired or contaminated groundwater for their water supplies, and struggle with the cost of providing safe drinking water. During the recent 2012 to 2016 drought, about two-thirds of drought-impacted public water systems and household water outages were in disadvantaged communities, and nearly one-third of drought-impacted systems served cumulatively burdened communities. These impacted communities are concentrated outside the Delta, in the San Joaquin Valley, the North Coast, and the Central Coast.[65] Similar geographic trends were also reported for drought-impacted household water systems (systems with fewer than 15 household connections, including individual household wells or water supplies).[66] Improvements to conveyance, system storage, and the operations of both can support sustainable water management in many areas of the state, especially disadvantaged

[62] California Department of Water Resources (DWR) 2017
[63] Water Code section 85303
[64] SWRCB 2013
[65] Disadvantaged communities have a median household income of less than 80 percent of the state median. Cumulatively Burdened Communities are those that rank in the top quarter of census tracts in the state for environmental burdens and socioeconomic vulnerability. Source: Feinstein et al. 2017. An interactive map of disadvantaged communities within California can be found at https://gis.water.ca.gov/app/dacs/.
[66] https://mydrywatersupply.water.ca.gov/report/publicpage

communities, and help assure the right to safe, clean, affordable and accessible water for human consumption and domestic use.

Reduced Reliance on the Delta

Many regions of the state rely on the Delta, to varying degrees, to meet their water supply needs. Reducing reliance on the Delta for water supply is essential to providing more flexibility in both meeting water supply reliability goals and protecting the ecosystem, especially in times of lower flow when there is maximum stress on both goals. Reducing reliance on the Delta is State policy, along with an associated mandate for improving regional self-reliance (Water Code section 85021), and reducing reliance is a prominent component of the Delta Plan (reflected in Chapter 3, which includes regulatory policy WR P1, Appendix G, and performance measures). Many agencies have made significant investments in developing their local and regional supplies, including groundwater banking, on- and off-stream surface water storage, recycled water, and desalinated supplies, while also achieving significant decreases in imported water demand through conservation and water use efficiency efforts. Reduced reliance on the Delta can be achieved through diversification of water supply portfolios at the regional and local levels, which will provide greater overall supply reliability during periods when water exports from the Delta are reduced.

Not all areas of the state have the same opportunities and resources to uniformly reduce reliance on Delta exports. Inland agricultural regions may not produce enough wastewater to replace agricultural irrigation with recycled water, although opportunities to use recycled water for groundwater recharge may be available. Other areas may be challenged by limited ability to dispose of brine, a byproduct of brackish and recycled water desalination, or geology and geography may limit the ability to store significant amounts of water during wetter periods. The cost effectiveness of any local supply strategy is of major importance and a valid criterion for any decision to implement a new local supply, as is avoiding or mitigating significant environmental impacts in the local area. Although new supply development opportunities may vary throughout the state, all regions reliant on Delta exports can reduce their reliance by increased water efficiency and aggressive water conservation.

New and improved conveyance, system storage, and the operations of both can complement water conservation and local supply development activities by providing a more stable and reliable source of supply. Combined with existing Delta Plan regulatory policy WR P1 and associated strategies for reduced reliance (see Chapter 3 and Appendix G), conveyance and storage can provide the flexibility local water managers need to sustainably manage their local supplies and reduce reliance on the Delta, especially during dry periods when the ecosystem is most vulnerable, water quality is degraded, and exports are limited.

Need for New and Improved Conveyance, Water Storage, and the Operations of Both

New and improved conveyance, water storage, and the operations of both—alongside other actions and policies identified in the Delta Plan—are integral to managing the Delta and

achieving the coequal goals. They are part of an integrated approach that uses all available water management tools to provide operational flexibility, while striving to achieve a balance among Delta uses recognized by the State. The cost of new and improved major storage and conveyance infrastructure will be significant, but the risk of taking no action is unacceptably high and will lead to additional, irreparable damage to the ecosystem and insufficient water supplies to support a healthy state economy.[67] Under climate change alone, average annual south of Delta SWP and CVP export reliability is expected to fall from about 4.9 MAF to about 4.6 MAF; this decline could be substantially larger should additional regulatory restrictions be placed on exports.[68] Maintaining the status quo will make achieving the coequal goals impossible in the future. To address the challenges and to meet the coequal goals, water managers operating California's water supply systems need to integrate their operation to take advantage of regional supply sources and leverage the use of new and existing facilities for conveyance, system storage, and the optimal operations of both.[69]

New and Improved Water Conveyance

The current system of natural and engineered conveyance infrastructure in the Delta lacks sufficient capacity and flexibility to manage water operations to benefit the ecosystem and enhance water supply reliability. System capacity and operational flexibility are needed to create more natural, variable flows and improve temperature conditions to support ecosystem health, maintain water quality for in-Delta uses, and move more water during wetter periods when supplies are available for both environmental and consumptive uses such that we can export less water from the Delta in dryer periods when native fish are more vulnerable.

Current water conveyance infrastructure is also aging and Delta channels are vulnerable to earthquakes, floods, and other hazards. Failure of this infrastructure poses significant risks for environmental harm and water supply disruption.[70] Climate change also is altering precipitation patterns in the Delta watershed and changing the timing and amount of stream flow, affecting water available for both ecosystem management and supply reliability. Sea level rise will increase salinity intrusion into the Delta, degrade water quality for agricultural and municipal uses in and outside the Delta, and alter ecosystem conditions.[71]

For well over 50 years, State, local, and federal entities have worked to identify long-term solutions to protect the beneficial uses of the Delta, including new and improved water conveyance in the Delta. Conveyance options considered over time have taken many different routes, forms, sizes, and configurations.[72] They have included isolated conveyance (moving water across or around the Delta via tunnels, pipelines, and aqueducts); improvements to

[67] Hanak et al. 2017
[68] DWR 2017
[69] Lund 2016; Gray et al. 2015; Lund et al. 2014; Null 2016
[70] Working Group on California Earthquake Probabilities 2003; Mount and Twiss 2005; Sneed et al. 2013; Farr et al. 2015; Robinson and Vahedifard 2016; Vahedifard et al. 2016
[71] Anderson et al. 2008; Fleenor and Bombardelli 2013; Van Lienden et al. 2014
[72] DWR et al. 2016

existing Delta channels and new Delta channels; and combinations of both isolated conveyance and through-Delta channels (also known as dual conveyance). Numerous operational scenarios have also been considered and evaluated that incorporate a range of upstream and in-Delta flow objectives, changed reservoir operations, changes to the timing of water conveyance and exports (seasonally and by year type), and many other regimes. A great body of work exists describing the potential positive and negative effects, risks, and uncertainties associated with different Delta conveyance options:

- If managed for conservation objectives, an isolated conveyance facility (one that moves water over, under, or around the Delta via artificial means) could facilitate more variable flow patterns, operating in a way that more closely mimics the natural flows that existed before the CVP and SWP export facilities were constructed and reducing entrainment—two actions scientists consider quite promising.[73] Construction of screened diversion and intake facilities in multiple locations in the Delta would also reduce reliance on the State and federal export facilities in the south Delta. Operation of the existing CVP and SWP export facilities draws water toward the south Delta, which can reverse the natural direction of flow in Old River, Middle River, and other Delta channels. These flow reversals disorient and reposition vulnerable fish populations, resulting in fish losses from entrainment, predation, and capture and release practices. Access to one or more intakes in the northern Delta would provide operational flexibility to reduce south Delta exports and limit harmful reverse flow conditions, particularly during periods of lower flow, while at the same time managing water quality. Needed improvements to Delta hydrodynamic conditions and aquatic habitat will be more difficult without some suitably operated form of isolated water conveyance.[74]

- Improvements to through-Delta conveyance alone are insufficient to provide effective protection for native fish, and to mitigate current water operation conflicts with listed species that result in export curtailments. Operational history and scientific studies indicate that exclusive dependence on south Delta pumping facilities will continue to cause reverse flow conditions in Old and Middle rivers, drawing salmon and smelt into the interior channels of the Delta where they are vulnerable to predation and entrainment. Further, anticipated changes associated with sea-level rise, land subsidence, invasive species, climate change, and earthquakes will make it impossible to preserve the Delta in its current state.[75] Significant cost and uncertainty is associated with maintaining existing through-Delta conveyance and export operations, including operation and maintenance of aging export facilities and costs to repair and improve levees and channels. In addition, increased salinity will impose higher water treatment costs on Delta water users on the order of hundreds of millions of dollars per year. The

[73] Hanak et al. 2013; Moyle and Bennett 2008; Fleenor et al. 2010
[74] Lund et al. 2008; Hanak et al. 2011; Moyle et al. 2012
[75] Moyle et al. 2012

cost of a large-scale levee failure from an earthquake, though difficult to estimate, would also be very high - both in terms of repair and restoration of affected levees and in terms of habitat loss and environmental harm.[76] Although physical improvements to through-Delta conveyance can complement isolated conveyance by providing additional fish protection measures, sole reliance on improved through-Delta conveyance is unlikely to result in achievement of the coequal goals.

- Even with the construction of some form of new isolated conveyance, through-Delta conveyance will remain an important component of California's water supply system. The implementation of isolated conveyance without consideration of flow needs within existing Delta channels and waterways has the potential for detrimental effects on water quality and associated resources (such as aquatic habitat and species, recreation, and in-Delta water uses). Depending on the location of new intakes, dual conveyance may decrease the salinity of exported water but additional flow releases from upstream reservoirs may be required to meet in-Delta salinity standards. Analyses of different options for dual conveyance indicate that some in-Delta agricultural water users may encounter more frequent periods of high salinity while others may experience the opposite.[77] With sea level rise, crop revenue losses in the Delta are estimated to be similar (less than 0.5%) with either through-Delta conveyance or dual conveyance of Delta exports.[78] To provide flexibility to adapt to changing conditions, conveyance solutions (both through-Delta and isolated conveyance) should be integrated and operated in tandem with enhanced water storage in the Delta watershed to optimally achieve the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

- California's hydrology is highly variable, requiring flexibility in water management operations to adjust to changing conditions. Adaptive management of new conveyance infrastructure in the Delta and its watershed can provide a framework for adjusting operations to changing conditions and our evolving understanding of ecosystem needs.[79] Adaptive management is a central component of the Delta Plan, and a requirement for covered actions under the plan's regulatory policy G P1.

- Large infrastructure projects ultimately have effects on the local environment and communities where the facilities are located. Above-ground isolated conveyance, in either a canal or above-ground pipeline, would permanently impact the landscape of the Delta—including native habitat, agriculture, transportation, recreation, and local communities. In comparison, below-ground conveyance reduces these impacts over the

[76] Lund et al. 2008
[77] Fleenor and Bombardelli 2013
[78] Medellín-Azuara et al. 2014
[79] Georgakakos et al. 2012

long-term.[80] However, below-ground conveyance – depending on its location, size, design, and associated physical details – still has the potential for impacts to Delta communities, including legacy communities[81], during extended construction periods that would span years. Several existing Delta Plan policies (which are regulatory) and recommendations (which are not regulatory) promote protection of Delta communities, land uses, and restoration opportunity areas that may be affected by new infrastructure.

- Delta Plan regulatory policy DP P2 requires water management infrastructure be sited to avoid or reduce conflicts with existing land uses and those uses described in general plans.

- Delta Plan recommendation DP R5 addresses the need to plan for the provision of adequate infrastructure, including streets and roads. A large-scale infrastructure project – taking place in multiple locations, on land and on waterways, over a decade or more – will impact existing and future planned infrastructure. Plans should be made to accommodate the goals of transportation planning in the affected area, as well as to mitigate those impacts.

- Delta Plan recommendation DP R14 is aimed at enhancing nature-based recreation within the Delta, and recommendation DP 17 promotes enhancing opportunities for visitor-serving businesses. Construction of new conveyance and future maintenance activities can negatively affect visitor-serving recreation and businesses, and thoughtful and collaborative planning is needed to minimize these impacts such that the intent of these recommendations can be achieved, even during an extended construction period.

- Delta Plan recommendation DP R3 encourages planning for the vitality and preservation of legacy communities.

- Delta Plan regulatory policy G P1 requires covered actions not exempt from CEQA to include applicable feasible mitigation measures identified in the Delta Plan's Program Environmental Impact Report, including those related to impacts to Delta communities.

Advice from the Delta Protection Commission, affected local communities and local governments, and agencies responsible for protecting and restoring the Delta environment must be considered in selecting conveyance alternatives and mitigation measures. Minimizing impacts during construction to the normal, daily course of business in the affected communities and minimizing disruptions during normal

[80] DWR et al. 2016

[81] A legacy community is a rural community registered as a Historic District by either a State or federal entity. Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, Locke, and Walnut Grove are the Delta's legacy communities (Public Resources Code section 32301(f)).

operations and maintenance activities should be a priority for facility planners. A phased construction schedule, developed in coordination with local governments and communities in the Delta, could help minimize disruptions from large-scale infrastructure construction activities. Mitigation measures appropriate to the physical scale of new conveyance facilities, the length of the construction period, and anticipated maintenance needs should be planned in collaboration with the affected communities to minimize disruptions to residents and businesses. Further, collaboration, communication, and public engagement should continue throughout design, construction and, ultimately, operation and maintenance of new facilities.

- There is a need to address impacts to terrestrial and aquatic species from new infrastructure development in the Delta. Delta Plan regulatory policy ER P3 requires avoidance of or mitigation for significant adverse impacts to high priority habitat restoration areas, including designing projects such that they will not preclude or interfere with future habitat restoration projects in these areas. Habitat mitigation projects should be implemented in advance of construction activities, such that replacement habitat is establishing and functioning prior to the start of construction. Furthermore, project proponents should design new or improved Delta conveyance infrastructure to enhance ecosystem restoration opportunities, flood risk reduction, recreation, and quality of life for Delta communities. New flow patterns linked with habitat restoration areas can create opportunities to re-establish important ecological processes associated with interactions between land and water that more closely resemble historical conditions within the Delta.[82] Conveyance infrastructure can and should be designed to enhance the connectivity of surrounding riparian and floodplain habitats, as well as in-Delta habitats, to better support native ecosystems.[83]

- It will take many years to implement large-scale improvements to conveyance infrastructure in the Delta and, even with the construction of such facilities, the CVP and SWP pumping facilities in the south Delta will continue to operate. Various studies have examined the feasibility of installing fish screens at Clifton Court Forebay or the entrance channels to the CVP and SWP pumping facilities. Most fish screens rely on sweeping flows moving past (parallel to) the screen to prevent impingement and entrainment; additionally, the terminal location and large pumping capacity of the CVP and SWP export facilities make it difficult to design a facility with sufficient sweeping flows to safely screen delta smelt and salmon. Further, fish screens would not address the effect that pumping operations have in reversing flows in some Delta channels and drawing fish toward the south Delta, where they would remain subject to predation and other harmful conditions. Given this, there is a need to identify and implement near-term actions to protect native fish and reduce fish losses associated with existing water

[82] Whipple et al. 2012
[83] Opperman et al. 2009; Hanak et al. 2013; DiFrancesco and Tullos 2014, 2015

export facilities, particularly in the south Delta.[84] This includes evaluating structural changes to the export facilities, improving salvage and release operations, and identifying, monitoring, and adaptively managing actions to address predation.[85]

Based on the findings and considerations identified above, new conveyance in the Delta should:

- Be a combination of new isolated conveyance and improved through-Delta conveyance facilities (dual conveyance) with access to multiple points of diversion, including one or more screened diversions;
- Be resilient to current and future hazards;
- Be adaptively managed and operated to adjust to changing conditions and scientific understanding, providing flexibility in operations to help achieve the coequal goals today and into the future;
- Be designed to avoid or minimize adverse effects while preserving and enhancing opportunities for ecosystem restoration, recreation, sustainable agriculture, and resilient local economies and communities;
- Be constructed and operated to minimize disruptions to the normal, daily course of business in affected communities, including minimizing disruptions during routine operations and maintenance; this includes implementing formal, collaborative processes with local governmental representatives to develop detailed construction implementation plans and policies that are responsive to the needs of affected communities, their economic activities, and quality of life during construction and beyond; and
- Be paired with near-term actions to address native fish losses at Delta export facilities.

Improved conveyance in the Delta can contribute to reducing fish losses and improving delivery reliability; however, conveyance alone is unlikely to provide the flexibility necessary to provide the water flow, temperature, and quality in the Delta and its watershed that are needed to achieve ecological goals. Similarly, improved Delta conveyance can improve export reliability but alone may not provide the flexibility needed for water managers to reduce reliance on the Delta and improve regional self-reliance. New conveyance in and outside the Delta should be developed and operated in coordination with existing and expanded storage systems (both surface storage and groundwater) to maximize the water management benefits and contributions to the coequal goals.

[84] California Natural Resources Agency 2016
[85] Grossman 2016; NMFS 2014; Gingras 1997

New and Expanded Water Storage

Improvements to conveyance alone are not sufficient to eliminate conflicts between water exports and species protection, or to optimize water system operations. Those conflicts are at their height during hydrologic extremes, such as droughts and floods. Water storage is an effective water management tool available to even out the variability of the state's hydrology across time and space, and to optimize the benefits of improved conveyance for both the environment and water supply reliability. For this reason, improvements to conveyance must be considered along with increased water storage to ensure that flow, temperature, and water quality needs can be managed in the Delta, now and into the future.

California's interconnected network of surface water and groundwater storage lacks the capacity and conveyance flexibility to manage ecosystem, water reliability, and public safety needs under the state's highly variable climate. New and expanded surface water reservoirs, improved groundwater storage, and the conjunctive management of both are critical to provide reliable water supplies for all uses, including flow and temperature management to benefit the Delta ecosystem in the face of increasingly intense drought and a changing climate.[86] With climate change, reservoirs in the Delta watershed will need to adjust their operations to accommodate warmer and more intense winter storms, more precipitation occurring as rainfall, and earlier spring snowmelt.[87] These changes will make it increasingly difficult to meet water temperature and flow objectives for native fish and water supply reliability for municipal, industrial, and agricultural uses. With current facilities and management practices, shifts in precipitation and runoff will directly affect deliveries and reservoir storage levels for the SWP and CVP. Lower carryover storage is projected for both the SWP and CVP, presenting risks for water supply reliability, hydropower production, and cold water pool storage for fish protection. The warmer climate and significant shift in seasonal runoff will result in consistently lower water delivery capability.[88] Further, warmer and more intense winter storms will require adjustments to reservoir operations to provide adequate space for floods and protect public safety, which may come at the risk of environmental and water supply needs if reservoirs cannot be refilled later in the season. Without new or expanded storage, current conflicts between the use of water for ecosystem management (flow and temperature), water quality (for in-Delta use and exporters), and supply reliability will only intensify.

New or expanded surface water and groundwater storage across the state can contribute in different ways to achieving the coequal goals. Improved water storage in the Delta watershed – both seasonal and permanent – can help manage flow and water quality conditions to support a healthier Delta ecosystem, while maintaining water quality for agricultural and municipal users, recreation, and fish. Native fish species may benefit from improved water storage in the Delta watershed, including storage space dedicated to ecosystem benefits such as flow management,

[86] Reclamation 2016; Ho et al. 2017
[87] Anderson et al. 2008; Huang et al. 2012; Berghuijs et al. 2014; Goulden and Bales 2014; Van Lienden et al. 2014; Savtchenko et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017
[88] Anderson et al 2008

water temperature management, other water quality benefits, or providing water supplies to wildlife refuges. However, it is recognized that opportunities for increased surface water storage on onstream reservoirs may be limited by potential ecological impacts. Studies indicate that the average annual amount of water available for storage in the Delta watershed is about 10 MAF, increasing to as much as 22 MAF in wet years.[89] As described in the Delta Plan (see page 74), the availability of water for diversion to storage or use is subject to the restrictions or conditions of specific water rights, as well as the operation restrictions of storage and transport facilities, physical and economic limitations, nonconsumptive uses (such as hydroelectric power generation), and the use and reuse of water.

New and expanded surface water and groundwater storage – within the Delta watershed, and within the Delta water export area – is needed to support reduced reliance on the Delta, achieve greater regional self-reliance, and sustainably manage the state's aquifers. Increased storage can allow water to be moved through the Delta when there are sufficient flows to support ecosystem needs and water can be more safely exported, for storage and later delivery when exports must be reduced to protect water quality and native fish. This shift in the timing of water movement and increased ability to carry over stored water from season to season can reduce reliance on the Delta during critical periods.

Groundwater provides about 40% of California's average annual total water supply, a figure that increases significantly during droughts and when surface water supplies are limited. Sustainable management of the state's groundwater resources is an important component of providing safe and reliable water supplies, contributing to reducing reliance on the Delta, and improving regional self-reliance. While difficult to quantify, available groundwater storage capacity in the state is estimated to exceed 200 MAF.[90] However, surface water supplies must be conjunctively managed with groundwater to leverage this available capacity and avoid groundwater overdraft, which can lead to subsidence and permanent loss of aquifer capacity. Expanded surface water storage can contribute to sustainable groundwater management by providing surface water at the right time for recharge and replenishment, providing water for in-lieu use to allow aquifers to recharge, and facilitate groundwater banking and exchange. This is particularly true in the San Joaquin Valley, where replenishment of aquifers and conjunctive use are limited by the availability of surface water supplies for recharge.

The value of new and/or expanded storage infrastructure should be assessed along with its connectivity to other surface storage, conveyance systems, and groundwater systems to maximize water supply and ecosystem benefits. Conveyance system integration affects the ability to make use of existing and new storage capacity in different parts of the state. Given the state's variable hydrology, the ability to operate conveyance in the Delta in a "big gulp, little sip" manner that balances ecosystem and water supply reliability needs is dependent on the

[89] Association of California Water Agencies 2017; DWR 2017;
[90] DWR 2015

availability of storage capacity in reservoirs and aquifers, and of conveyance infrastructure to move water supplies to and from storage facilities.

Improved Operations of Storage and Conveyance

The operation of water management projects in and tributary to the Delta are subject to laws and regulations administered and enforced by a variety of agencies, including water flow and quality standards as defined by the State Water Resources Control Board. These laws and regulations effect the operation of upstream reservoirs to meet flow and quality standards, and govern the timing and volume of water that may be conveyed through and exported from the Delta. Water operations are also subject to the conditions associated with individual water rights. Within this regulatory environment, a complex system of State, federal, and local water management infrastructure in the Delta and its watershed is operated to meet diverse and increasingly competing needs.[91]

Many of the State's conveyance and storage systems are inextricably linked by the Delta and surrounding environments, and conveyance and storage must be operated in an integrated manner to realize their full and combined potential. This includes operations to take better advantage of periods of ample supply such that less water is exported during critical dry periods. Operational flexibility is particularly important when considering climate change and uncertainties associated with future water demands.[92] Further, sustained drought conditions are expected to intensify in the future, putting additional stress on the operation of Delta conveyance and water storage infrastructure to meet both ecosystem and water supply needs.

Given these challenges and uncertainties, adaptive management is critical to successfully operating water management facilities in the Delta to achieve the coequal goals, as described in the Delta Plan. Adaptive management should address specific and measurable operating objectives for ecosystem and water quality requirements, changing climate conditions, and changing water demands.[93] Further, for adaptive management to be successful, adequate funding must be provided to monitor conditions before, during, and after projects are implemented. Water management systems in the Delta must be operated to reduce hydrodynamic and biological impacts of exporting water through Jones and Banks pumping plants and minimize the frequency, magnitude, and duration of reverse flows in Old River and Middle River in order to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento rivers into the southern or central Delta substantially increasing their likelihood of mortality.[94] Studies suggest that SWP and CVP water diversion impacts on fish can be mitigated by altering the timing of exports, and that fish losses can by minimizing reverse flows during

[91] Lund 2016
[92] Georgakakos et al. 2012
[93] Georgakakos et al. 2012; Null et al. 2014; Kistenmacher and Georgakakos 2015; Null and Prudencio 2016; Rheinheimer et al. 2016
[94] NMFS 2016, NMFS 2009

periods when delta smelt and other fish are migrating into the Delta.[95] Conveyance operations must also be coordinated with storage operations to provide adequate flows in the Delta to meet the needs of fish and other native species.

The benefits of coordinating surface and groundwater storage with conveyance operations greatly surpasses the benefits of expanding storage capacity alone.[96] Integrated or coordinated operation of conveyance and storage, within and outside of the Delta, can contribute to sustainable management of the state's aquifers, promote conjunctive use, leverage local supplies, and reduce reliance on the Delta during dry periods and droughts. A recent study by the Association of California Water Agencies indicates that integrating the operation of eight proposed storage projects (both north and south of the Delta) with expanded conveyance in the Delta can improve delivery reliability and contribute to sustainable groundwater management over expanding storage alone, while meeting regulatory flow and water quality requirements. For example, the study estimated an average annual increase in water deliveries with the proposed storage projects alone of about 400 thousand acre-feet (TAF); this figure increased to about 800 TAF when simulated in combination with improved Delta conveyance. Similarly, the study showed reduced groundwater pumping and increased recharge with a combination of storage and conveyance. Groundwater storage increased by about 250 TAF annually with new storage projects alone, increasing to 460 TAF annually with a combination of storage and improved Delta conveyance.[97] Other studies have suggested that groundwater storage in the San Joaquin Valley alone could increase by as much as 500 TAF with a combination of new surface storage and conveyance improvements.[98]

A recent study by DWR shows more than 1 MAF of surface water available on an average annual basis for groundwater replenishment within the Delta watershed and areas receiving Delta export supplies.[99] Conveyance improvements with expanded surface storage can increase the ability to capture and transport surface water supplies for groundwater recharge and replenishment and/or in-lieu recharge. Surface storage can be operated to store water during wet periods, for delivery in late spring and summer and during dry periods as in-lieu supply for existing groundwater users; this operation increases the use of available groundwater storage capacity, providing greater water supply benefits than if surface and groundwater facilities were operated independently.[100]

By taking into account effects on the Delta, conveyance outside of the Delta can be operated to complement Delta conveyance and expanded storage. Local conveyance improvements and sustainable water management actions taken outside the Delta can contribute to the coequal

[95] Grimaldo et al. 2009
[96] Lund et al. 2014
[97] Association of California Water Agencies 2017
[98] Lund et al. 2014
[99] DWR 2017
[100] Lund et al. 2014

goals through a comprehensive, integrated water management approach that considers multiple water supply sources, including but not limited to surface water storage, groundwater, stream flow, imported water, water transfers, stormwater, desalinated water, and recycled water, as applicable.[101]

RECOMMENDATIONS

With regard to new and improved infrastructure—relating to water conveyance in the Delta, water storage systems, and the operation of both to achieve the coequal goals—the Delta Plan promotes the design, implementation, and operation of new and improved water conveyance infrastructure and new or expanded water storage that are consistent with the criteria in Sections I, II, and III, below. To develop a robust water management system that provides flexibility to adapt to changing conditions, conveyance should be integrated and operated in tandem with enhanced water storage in the Delta watershed and the Delta export area to optimally achieve the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. Sections I, II, and III contain a suite of actions to be collectively pursued in an integrated manner with existing Delta Plan policies and recommendations. All promoted options should be managed so Delta water supplies further the coequal goals and incorporate the best currently available science and adaptive management. Further, Delta Plan performance measures can assist the Council in tracking progress in meeting its objectives, including those related to conveyance, storage systems, and the operation of both.

These provisions are recommendations; they are not regulations.

They are intended to provide guidance to agencies implementing projects but do not apply to a project's consistency with the Delta Plan under Water Code section 85225, or any appeal to the Council of a certification under Water Code sections 85225.5 et seq.

I. NEW AND IMPROVED WATER CONVEYANCE

A. Promote Options for New and Improved Infrastructure Related to Water Conveyance

Subject to completion of environmental review and approval by the lead agency, and applicable regulatory approvals from other public agencies, the following infrastructure options are hereby promoted.

1. The California Department of Water Resources (DWR) the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), and local beneficiary agencies should pursue a dual-conveyance option for the Delta. Dual conveyance is a combination of through-Delta

[101] Howitt et al. 2010; Hanak et al. 2012; Howitt et al. 2015

conveyance and isolated conveyance to allow operational flexibility. Dual conveyance alternatives should be evaluated, and a selected plan designed and implemented, consistent with Section I.B., below. Dual conveyance should incorporate existing and new intakes and facility improvements for both isolated, below-ground conveyance and through-Delta conveyance of State Water Project (SWP) and Central Valley Project (CVP) water supplies from the Sacramento River to the south Delta, as follows:

(a) The isolated conveyance should incorporate one or more new screened intakes that protect native fish and that are operated to minimize harmful reverse flow conditions in Old and Middle rivers while maintaining water quality for in-Delta uses. Isolated conveyance should complement existing and improved through-Delta conveyance to promote operational flexibility, protect water quality, and support ecosystem restoration.

(b) To protect the Delta ecosystem, the State Water Resources Control Board should ensure that operational criteria for new and improved conveyance facilities comply with applicable State Water Resources Control Board requirements, including any flow criteria adopted pursuant to Water Code 85086(c)(2).[102]

(c) Dual conveyance requires continued maintenance and further improvement of through-Delta conveyance. Through-Delta conveyance improvements may include channel improvements consistent with the Delta Plan and additional facilities that could provide for improved operations for native fish protection.

2. DWR in collaboration with local beneficiary agencies should pursue new intake and conveyance facilities for conveying SWP supplies from the Sacramento River to SWP contractors in Solano and Napa Counties. This is both to protect native fish and improve the quality and reliability of water supplies delivered via the North Bay Aqueduct.

3. Local agencies, in coordination with DWR and Reclamation, should pursue new conveyance facilities or conveyance facility improvements that allow use of multiple Delta intakes associated with the Los Vaqueros Project. This would increase operational flexibility for local, SWP, and

[102] Water Code section 85086(c)(2) provides, "Any order approving a change in the point of diversion of the State Water Project or the federal Central Valley Project from the southern Delta to a point on the Sacramento River shall include appropriate Delta flow criteria and shall be informed by the analysis conducted pursuant to this section. The flow criteria shall be subject to modification over time based on a science-based adaptive management program that integrates scientific and monitoring results, including the contribution of habitat and other conservation measures, into ongoing Delta water management."

CVP municipal and environmental[103] water supplies conveyed from the south Delta.

4. DWR, Reclamation, and local beneficiary agencies, in coordination with the California Department of Fish and Wildlife, National Marine Fisheries Service and U.S. Fish and Wildlife Service, should evaluate and identify for near-term implementation feasible actions to contribute to reducing fish losses associated with existing pumping operations at the Banks Pumping Plant and Jones Pumping Plant, consistent with the 2009 *Biological Opinion and Conference Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan;* the 2009 *Biological Opinion on the Coordinated Operations of the Central Valley Project and State Water Project in California;* and the 2014 *Recovery Plan for Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead*. These actions may include, but are not limited to:

   (a) Implementing changes to the operations and physical infrastructure of the facilities where such changes can improve fish screening and salvage operations and reduce mortality from entrainment and salvage.

   (b) Evaluating and implementing effective predator control actions, such as fishery management or directed removal programs, for minimizing predation on juvenile salmon and steelhead in Clifton Court Forebay and in the primary channel at the Tracy Fish Collection Facility.

   (c) Evaluating and implementing effective predation reduction actions associated with salvage operations, such as transporting and releasing fish in multiple locations in the Delta.

   (d) Installing equipment to monitor for the presence of predators and to monitor flows at the fish collection facilities.

   (e) Modifying Delta Cross Channel gate operations and evaluating methods to control access to Georgiana Slough and other migration routes into the interior Delta to reduce diversion of listed juvenile fish from the Sacramento River and the San Joaquin River into the southern or central Delta.

[103] "Environmental water" is defined in the Delta Plan as providing minimum flow levels of a specific quality that are needed in order to assure the continued viability of fish and wildlife resources for a particular water body. This water is used to maintain and enhance the beneficial uses related to the preservation and enhancement of fish, wildlife, and other aquatic resources or preserves as specified in the Porter-Cologne Water Quality Control Act. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.

B. Evaluate, Design, and Implement New or Improved Conveyance or Diversion Facilities in the Delta

1. In selecting new and improved Delta infrastructure for conveying SWP, CVP, and market transfer water supplies from the Sacramento River to the south Delta, project proponents should analyze and evaluate a range of alternatives that includes all of the following:

   (a) A reasonable range of flow criteria, rates of diversion, and other operational criteria required to satisfy applicable requirements of State and federal fish and wildlife agencies and the State Water Resources Control Board, and other operational requirements and flows necessary for protecting, restoring, and enhancing the Delta ecosystem under a reasonable range of hydrologic conditions (as described under Section III.B, below). This includes identifying water available for export and other beneficial uses[104], consistent with water quality requirements of the State Water Resources Control Board.

   (b) A reasonable range of dual-conveyance alternatives, including options for the number and location of new intakes, a range of isolated conveyance capacities, through-Delta conveyance improvements, and other facilities that could improve operations for native fish and in-Delta water quality, as applicable.

   (c) The potential effects of climate change on the conveyance alternatives under consideration, including possible precipitation and runoff pattern changes, temperature, and sea level rise estimates consistent with guidance provided by the California Natural Resources Agency, National Research Council, or other appropriate projections.

   (d) The potential effects on migratory fish and aquatic resources and habitats.

   (e) The potential effects on Sacramento River and San Joaquin River flood management.

   (f) The resilience and recovery of Delta conveyance alternatives to catastrophic failure caused by earthquake, flood or other natural disaster.

[104] The Delta Plan defines beneficial use as uses of the waters of the state that include domestic, municipal, agricultural, and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves (Delta Stewardship Council, 2013, as amended, and defined in sections 659-669 of 23 California Code of Regulation, Division 3, Chapter 2, Article 2).

(g) The potential effects of each Delta conveyance alternative on Delta water quality, flows, and water levels, including the effects of these changes on in-Delta water users.

(h) The operational benefits and/or detriments of providing multiple intake locations.

(i) The potential short-term and long-term effects of each Delta conveyance alternative on terrestrial species.

(j) The potential effects of each Delta conveyance alternative on the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

(k) The cost-effectiveness of the alternatives in furthering the coequal goals. Cost-effectiveness means the degree to which a project or action is effective in achieving desired outcomes in relation to its cost.[105]

2. Project proponents should design and implement new or improved conveyance infrastructure in the Delta consistent with the following parameters:

(a) Located in areas with seasonally favorable freshwater conditions, and areas that are less vulnerable to degradation during sustained droughts and under anticipated future climate change and sea level rise conditions.

(b) Located to avoid impacts to and, where possible, improve conditions for habitat restoration opportunities in priority restoration areas identified in the Delta Plan, and other important restoration opportunity areas identified by the California Department of Fish and Wildlife.

(c) Located, designed, and operated to minimize adverse conditions for native aquatic and terrestrial species, including but not limited to those conditions related to flow direction and water quality.

(d) Designed to avoid or minimize native fish entrainment and impingement.

[105] A cost effectiveness analysis assesses the degree to which a project or action is effective in achieving desired outcomes in relation to its cost. A cost-effectiveness analysis differs from a cost–benefit analysis, which assigns a monetary value to the outcomes or effects and compares that monetary value to the cost. Cost effectiveness is often applied where it may be inappropriate or difficult to assign monetary value to the outcomes or effects, such as ecosystem benefits or public health outcomes. In the context of evaluating alternatives, a cost effectiveness analysis can help identify the least costly way of achieving a desired benefit.

(e) Designed to balance adverse project impacts against the project's long- and short-term benefits.

(f) Designed to minimize disruptions to transportation and business activities during routine maintenance activities, with consideration given to scheduling planned maintenance activities in consultation with local governments to minimize impacts to residents and businesses, and establishing communication protocols to notify residents of planned and unplanned maintenance activities.

(g) Designed to complement the Delta landscape and minimize aesthetic impacts, including visual impacts of spoils material stockpiles.

(h) Designed to maximize beneficial reuse of spoils materials to the extent practicable and feasible.

(i) Implemented in accordance with detailed project implementation plans developed in cooperation with affected communities, local governments, the Delta Protection Commission, and stakeholders to minimize and/or mitigate adverse environmental effects consistent with Delta Plan Policy GP 1, and avoid or reduce conflicts with existing or planned land uses consistent with Delta Plan Policy DP P2, and in consideration of Delta Plan recommendations DP R14, DP R16 and DP R17. Project implementation plans should consider and protect the unique character and historical importance of legacy communities,[106] be consistent with the State's policy regarding the human right to water, and incorporate good neighbor policies to avoid negative impacts on agricultural lands, residents, and business. Items that should be addressed in the plans include, but are not limited to, the following:

(i) Construction sequencing or phasing;

(ii) Temporary and long-term spoils placement;

(iii) Plans for temporary traffic routing that are consistent with local transportation plans, including consideration of permanent improvements to transportation and alternative transportation routes to avoid the most severe impacts to levels of service during construction;

(iv) Effects of construction activities on recreation and other visitor-related activities and businesses, including

[106] Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, Locke, and Walnut Grove are the Delta's legacy communities (Public Resources Code section 32301(f)).

disruptions to transportation, temporary waterway closures, aesthetic and noise effects, and access to marinas, parks, and other recreation facilities;

(v) Effects on local surface water and groundwater supplies during construction;

(vi) Mechanisms for communicating with landowners, communities, and local governments before and during construction;

(vii) Mechanisms by which community members and stakeholders can raise concerns during construction and in association with ongoing facility operations and maintenance; and

(viii) Legally-permissible project delivery methods which are cost effective and provide for an expedited design and construction timeline that minimizes disruption to affected communities.

C. Improve or Modify Through-Delta Conveyance

1. Project proponents should design, implement, and adaptively manage improved or modified through-Delta conveyance and appurtenant facilities (such as gates, permanent barriers, or fish handling facilities) to:

(a) Substantially lessen or avoid impacts and provide net improvements to riparian habitat and channel margin habitat along anadromous fish migratory corridors and, where feasible, enhance conditions for native fish.

(b) Substantially lessen or avoid impediments and provide net improvements to anadromous fish migration.

(c) Substantially lessen or avoid impacts to public safety and include or contribute to levee improvements along Old and Middle Rivers consistent with Chapter 7 of the Delta Plan.

(d) Modify the conveyance capacity or hydraulic characteristics of existing Delta waterways (e.g., improving levees and/or dredging) in a manner that provides multiple benefits, including: taking advantage of periods when water flow and quality conditions are favorable for improving water supply delivery reliability, quality, and flexibility and for protecting, restoring, and enhancing the Delta ecosystem; improving floodplain values and functions; improving habitat conditions during fish migration; and reducing flood risks.

II. NEW AND IMPROVED WATER STORAGE

A. Promote Options for New or Expanded Water Storage

Subject to completion of environmental review and approval by the lead agency, and applicable regulatory approvals from other public agencies, options for new or expanded water storage are hereby promoted as follows:

1. Within the Delta watershed, project proponents should design and operate new or expanded offstream or onstream surface water storage projects consistent with the criteria in Section III.B. to:

   (a) Provide water supply reliability[107], water quality, operational flexibility to adapt to changing conditions, and ecosystem benefits under variable hydrologic conditions, and, where possible, flood risk management benefits.

   (b) Improve resilience to the effects of climate change, sea level rise, higher stream temperatures, long-term drought conditions, and emergency supply disruptions.

   (c) Allow greater flexibility in storing water supplies during periods when more water is available for carryover into periods when less water is available and/or Delta exports are reduced.

   (d) Take advantage of periods when the water flow, quality, and environmental requirements of State and federal agencies are being met, for improving water supply delivery reliability and flexibility and protecting, restoring, and enhancing the Delta ecosystem.

   (e) Contribute to improved conjunctive management[108] of both surface and groundwater resources to maximize efficient water use and contribute to sustainable management of groundwater basins, consistent with the Sustainable Groundwater Management Act.

2. Within the Delta water export area, project proponents should implement new or expanded surface water storage projects that improve resilience to the effects of climate change and drought and are operated to allow storage of exported and local surface water supplied during wetter

[107] "Water supply reliability" is defined in the Delta Plan, in general terms, as providing a more reliable water supply for California by better matching the state's demands for reasonable and beneficial uses of water to the available water supply. See also Chapter 3 of the Delta Plan (Delta Stewardship Council, 2013, as amended).
[108] Conjunctive management is the coordinated and planned management of both surface water and groundwater resources to maximize efficient water use. Water is stored in groundwater basis for future use by intentionally recharging the basin during year of above-average surface water supply. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.

periods for use during dryer periods when exports from the Delta are reduced. Opportunities to store stormwater and recycled water supplies of suitable quality should also be promoted as a strategy for improved regional water management and reduced reliance on the Delta. This includes projects in the San Francisco Bay Area, San Joaquin Valley, Central Coast region, and Southern California.

3. Within the Delta watershed and Delta water export area, project proponents should implement groundwater storage and extraction projects, including facilities for groundwater withdrawal, recharge, injection, and monitoring that are consistent with the criteria in Sections II.C below.

4. The State Water Resources Control Board should review and consider revisions to existing regulations to facilitate the safe use of recycled water, stormwater, and other local water supplies for groundwater replenishment.

B. Design, Construct and Implement New or Expanded Surface Water Storage

1. Project proponents should design, implement, and adaptively manage new or expanded surface storage[109] projects in the Delta, its watershed, and Delta water export areas to:

   (a) Improve resilience of the State's water supply system through demonstration of benefits under current and anticipated future conditions, including climate change, changing water demands, and regulatory conditions.

   (b) Contribute to regional self-reliance and reduced reliance on the Delta.[110]

   (c) Demonstrate contributions to the goals of the Sustainable Groundwater Management Act by promoting conjunctive use to achieve long-term groundwater basin sustainability.

   (d) Enable participation in water exchanges and transfers that benefit the Delta ecosystem and improve regional water supply reliability.

   (e) Demonstrate cost-effectiveness, where cost-effectiveness means the degree to which a project or action is effective in achieving desired outcomes in relation to its cost.

[109] "Surface storage" is defined in the Delta Plan as Reservoirs used to collect and hold water for future release and use. See also Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.
[110] "Regional self-reliance" is defined in the Delta Plan as the degree to which a region implements water management options so that it can provide for all of its needs for water from within its own borders. See also see regulatory policy WR P1 and recommendations WR R4 and WR R18 of the Delta Plan, Delta Stewardship Council, 2013, as amended.

(f) Minimize and mitigate the impacts of storage on stream flows and water quality, including impacts during construction.

2. Project proponents should design and implement new or expanded surface water storage projects in the Delta and Delta watershed, where feasible, to further achievement of the coequal goals by:

(a) Providing for the dedicated storage of water[111] during wet periods for carry over and later use during dry periods, while balancing the benefits of providing more natural, functional flows[112] to the Delta and its tributaries, meeting other ecosystem needs and providing flood risk management benefits.

(b) Enhancing water temperature management on Delta tributaries either directly or through coordinated operations with other facilities.

(c) Incorporating storage space dedicated to ecosystem benefits, such as flow management, water temperature, other water quality benefits, or providing water supplies to wildlife refuges.

(d) Integrating new and/or expanded storage with other existing or planned storage and conveyance systems to increase ecosystem and water supply benefits. This includes developing and/or updating coordinated operations plans, and/or agreements with other storage and conveyance systems.

(e) Contributing to the protection of water quality in the Delta and its watershed for all beneficial uses consistent with the State Water Resources Control Board's Bay-Delta Plan.

(f) Contributing to more natural, functional flows that support ecosystem health.[113]

3. Project proponents should design and implement, where feasible, new or expanded surface water storage projects outside the Delta watershed, but within the Delta water export area, such as projects within the San Joaquin Valley, Central Coast, or Southern California regions, to:

(a) Contribute to reduced reliance on the Delta and regional self-reliance and, particularly during dry periods, through storage of available water supplies during wet periods for use during dry periods.

[111] "Dedicated water" is defined by the California Department of Water Resources as water distributed among urban and agricultural uses, used for protecting and resorting the environment, or storage in surface water and groundwater reservoirs. See Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended.
[112] Defined on page 134 of Chapter 4 of the Delta Plan, Delta Stewardship Council, 2013, as amended.
[113] Defined in the Delta Plan, Delta Stewardship Council, 2013, as amended.

(b) Promote conjunctive management of surface and groundwater resources, and contribute to achieving groundwater sustainability goals established pursuant to the Sustainable Groundwater Management Act or applicable local plans, as appropriate.

(c) Contribute to a comprehensive, integrated water management approach that considers multiple water supply sources including, but not limited to, stream flow, groundwater, imported water, stormwater, and recycled water, as applicable.

C. Implement New or Expanded Groundwater Storage

1. Funding, planning, and technical support provided by State and regional agencies for groundwater projects should:

(a) Promote multiple benefits, minimize harmful effects to the ecosystem, help achieve Bay-Delta Plan objectives, as applicable, and be consistent with guidance from the State Water Resources Control Board and DWR for implementing the Sustainable Groundwater Management Act.

(b) Promote increased groundwater recharge using locally available water, such as recharge via stream-aquifer interactions, floodwater or stormwater capture, recharge using recycled water, or others, provided such actions do not result in harmful impacts to functional flows in local streams.

(c) Promote conjunctive management of surface water and groundwater resources, including in-lieu recharge.

(d) Promote new or expanded groundwater banking and exchange projects.

(e) Promote the construction of new or improved local conveyance infrastructure to convey water to and from groundwater recharge and recovery facilities.

(f) Promote the construction of new or improved conveyance infrastructure that interconnects Delta export conveyance facilities with local conveyance facilities.

(g) Promote implementation of the Central Valley Salt and Nitrate Management Plan and achievement of management goals and priorities for protection of water quality, where appropriate.

(h) Promote wellhead treatment, access to conjunctively-managed surface supplies, or other means of providing access to safe, clean, and affordable water supplies for communities relying on impaired groundwater.

(i) Demonstrate consistency with applicable Groundwater Sustainability Plans under the Sustainable Groundwater Management Act.

(j) Include new infrastructure that is consistent with Sections II.C(a)-(c), above.

(k) Assess the ecosystem and water supply impacts and benefits to the Delta, including providing mitigation, as appropriate.

(l) Promote opportunities for storage of flood waters (e.g., floodplain storage) or stormwater that can be managed for groundwater recharge.

2. DWR should develop a model ordinance for groundwater recharge that urges cities and counties to incorporate groundwater recharge and storage into land-use planning and zoning, and to protect areas with the highest potential for groundwater recharge from incompatible uses. (Note: A representative map showing the soil suitability index for groundwater banking projects on agricultural lands is shown in Attachment A [Figure C-1].)

3. DWR or the State Water Resources Control Board should prepare a proposal for an incentive program, in coordination with the Department of Conservation or the U.S. Department of Agriculture's conservation programs, for landowners to protect lands with high groundwater recharge potential for the purpose of contributing to sustainable groundwater management.

III. IMPROVE OPERATIONS OF STORAGE AND CONVEYANCE

A. Promote Options for Operations of Storage and Conveyance Facilities

Subject to completion of environmental review and approval by the lead agency, the following options for the operation of conveyance and storage are hereby promoted:

1. DWR, in coordination with Reclamation, should develop a Drought Water Operations Strategy for the SWP and CVP to meet State Water Resources Control Board-specified flow and water quality criteria during extended drought conditions lasting up to six years, or for the extended timeframe recommended by the Real Time Drought Operations Team (RTDOT)[114] describing opportunities and tools to improve routine operations to adapt to drought conditions. In developing the Strategy, DWR and Reclamation should include criteria for defining appropriate

[114] RTDOT includes: CA Department of Water Resources, CA Department of Fish and Wildlife, State Water Resources Control Board, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and National Marine Fisheries Service.

levels or stages of drought affecting the North, Central, and South Delta Water Agencies. The Strategy should consider in-Delta actions and activities, and operations and storage of other facilities or projects that support achievement of the coequal goals. This strategy should be submitted to the Delta Stewardship Council by 2020 and be updated following future declarations of emergency associated with extreme hydrological conditions pursuant to the California Emergency Services Act (Government Code Sections 8550-8668), within one year of completing an After-Action Report, or when physical or regulatory changes necessitate an update.

2. DWR and Reclamation should use an adaptive management approach, consistent with the Delta Plan's adaptive management framework[115] and in alignment with existing collaborative adaptive management efforts, for the coordinated operation of SWP and CVP through-Delta conveyance to promote the coequal goals, including considerations for protecting, enhancing, and restoring the ecosystem and maintaining adequate flows, flow direction, water levels, and water quality for Delta agriculture, recreation, and communities.

3. Lead agencies for new or modified conveyance facilities, and new and expanded storage facilities—including those options identified in I.A. and II.A., above—should develop operational plans consistent with Section III.B., below.

4. To improve water management flexibility and to support coordinated operations with new storage facilities, local agencies—in coordination with DWR and Reclamation, as appropriate—should pursue the following new or improved conveyance facilities outside of the Delta, to reduce reliance on the Delta and promote regional self-reliance[116]:

   (a) Facilities that promote the movement or exchange of SWP, CVP, and local water supplies, such as between the east and west sides of the San Joaquin Valley or between other regions.

   (b) Facilities that improve groundwater recharge and/or conjunctive use in overdrafted aquifers of the San Joaquin Valley, Tulare Lake Basin, and other Delta water export areas.

   (c) Facilities that increase groundwater banking or exchange, or that promote increased use of stormwater, recycled water, desalinated water, or other local water supplies in regions tributary to, or that rely on, Delta water supplies.

[115] See page 38 of the Delta Plan, Delta Stewardship Council, 2013, as amended.
[116] See regulatory policy WR P1 and recommendations WR R4 and WR R18 of the Delta Plan, Delta Stewardship Council, 2013, as amended.

B. Operate Delta Water Management Facilities Using Adaptive Management Principles

1. Project proponents should develop plans for the operation or reoperation of water conveyance and control facilities in the Delta, or new or modified storage facilities in the Delta and its watershed, that incorporate adaptive management consistent with the Delta Plan's adaptive management framework[117] and further achievement of the coequal goals by:

   (a) Including specific and measurable operating objectives (consistent with State Water Resources Control Board's Bay-Delta Plan objectives), that address:

      (i) Protection for and enhancements to the Delta ecosystem, including improved water temperature management, while reliably delivering water.

      (ii) Avoidance or mitigation of adverse effects on in-Delta recreation and in-Delta water quality, including identifying salinity targets for the south Delta that are designed to prevent severe water quality degradation and toxic events in dry and critically dry years.

      (iii) Avoidance or mitigation of adverse effects on stream flows and water quality.

      (iv) Avoid or mitigate adverse effects on agriculture in the Delta, including identifying salinity targets suitable for the types of crops grown in the Delta.

      (v) Protection of the quality, reliability, and affordability of water supplies for communities relying on impaired water supplies, including disadvantaged communities, consistent with California Water Code section 106.3.

   (b) Enabling diversions during periods when Delta water flow, quality, and environmental requirements are being met for improving water supply delivery reliability and flexibility to changing conditions, and for protecting, restoring, and enhancing the Delta ecosystem.

   (c) Incorporating adaptive management plans, consistent with the Delta Plan's adaptive management framework[118] and developed in coordination with operators and applicable regulatory agency staff, for modifying operations to meet State Water Resources Control

[117] See page 38 of the Delta Plan, Delta Stewardship Council, 2013, as amended.
[118] See page 38 of the Delta Plan, Delta Stewardship Council, 2013, as amended.

Board flow and water quality requirements, and California Department of Fish and Wildlife conservation and recovery goals, under the following:

(i) Extended drought conditions (more than three years in duration).

(ii) Changed climate conditions including sea level rise and changed hydrologic conditions over the anticipated project life.

(iii) Extreme wet years and flood events.

(d) Demonstrating that projects can contribute to a more reliable water supply, and can protect, restore, and enhance the Delta ecosystem under a range of future conditions, including changing climate and sea level rise projections from the California Natural Resources Agency or National Research Council, or other appropriate projections.

(e) Evaluating the applicability of forecast-informed reservoir operations.

(f) Considering coordination and integration of operations with existing and/or planned conveyance and water storage facilities to maximize their potential to contribute to the goals of the Sustainable Groundwater Management Act, and the goals of other applicable programs and plans related to sustainable groundwater, stormwater, and floodwater management.

(g) Reviewing and updating, as needed, the flood space reservation guidelines for upstream reservoirs in coordination with the U.S. Army Corps of Engineers and reservoir owners or operators.

2. Project proponents should develop operation plans for new water conveyance facilities in the Delta, and new or expanded storage facilities in the Delta watershed, that:

(a) Ensure that operations are adequately monitored, evaluated, and revised using adaptive management to make progress towards achieving defined performance measures.

(b) Be based upon accurate, timely, and transparent water accounting and budgeting.

(c) Ensure that operations provide water levels, water flow, and water quality suitable for in-Delta agricultural and recreational uses.

C. Update the Bay-Delta Plan and Consider Drought

1. In developing and implementing updates to the Bay-Delta Plan, and flow requirements for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed, the State Water Resources Control Board should:

   (a) Consider and contribute to achievement of applicable Delta Plan performance measures.

   (b) Require water diverters in the Delta and its watershed that are responsible for meeting Bay-Delta Plan requirements, including but not limited to DWR and Reclamation, to develop a process and plan for meeting applicable flow and water quality requirements during extended drought conditions (characterized by multiple, successive dry years) to further the coequal goals and minimize reliance on temporary urgency change petitions and related requests.

D. Operate New or Improved Conveyance and Diversion Facilities Outside of the Delta

1. Conveyance facilities outside the Delta should be operated in consideration of effects on Delta water quality, the timing and magnitude of flows in the Delta, water supplies available for export from the Delta, and effects on opportunities to protect, restore, and enhance the Delta ecosystem.

2. In allocating funding for new water conveyance and conveyance improvement projects outside the Delta that support regional self-reliance, the State should give preference to projects that:

   (a) Reduce reliance on the Delta for water supply during dry and critically dry years by the specific designation, in operational agreements or plans, of carryover storage for beneficial use during these periods.

   (b) Improve conjunctive management of surface and groundwater resources and contribute to achieving groundwater sustainability goals established pursuant to the Sustainable Groundwater Management Act or local plans, as appropriate.

   (c) Support ecosystem enhancement and/or provide more natural, functional flows[119] in the Delta and its tributaries.

[119] Delta Plan, Delta Stewardship Council, 2013, as amended.

(d) Improve the ability of regions that rely on the Delta, for all or a portion of their water supplies, to withstand and adapt to changing current and future hydrologic conditions.

(e) Improve the quality, reliability, and affordability of water supplies for communities relying on impaired water supplies, including disadvantaged communities, consistent with California Water Code section 106.3.

(f) Contribute to a comprehensive, integrated water management approach that considers multiple water supply sources including, but not limited to, stream flow, groundwater, imported water, stormwater, desalinated water, water saved through increased efficiency, and recycled water, as applicable.

(g) Improve flexibility to accommodate water market transfer and exchange opportunities that benefit the environment.

E. Promote Water Operations Monitoring Data Management, and Data Transparency

In meeting the requirements of the 2016 Open and Transparent Water Data Act, DWR should coordinate with the Council to incorporate information related to Delta Plan performance measures and links to the Council's online tracking and reporting tools, as appropriate, in an effort to promote transparency and accessibility of data in tracking progress toward achieving the coequal goals.

DISCUSSION DRAFT
NOT APPROVED BY THE DELTA STEWARDSHIP COUNCIL
SUBJECT TO CHANGE

ATTACHMENT A.

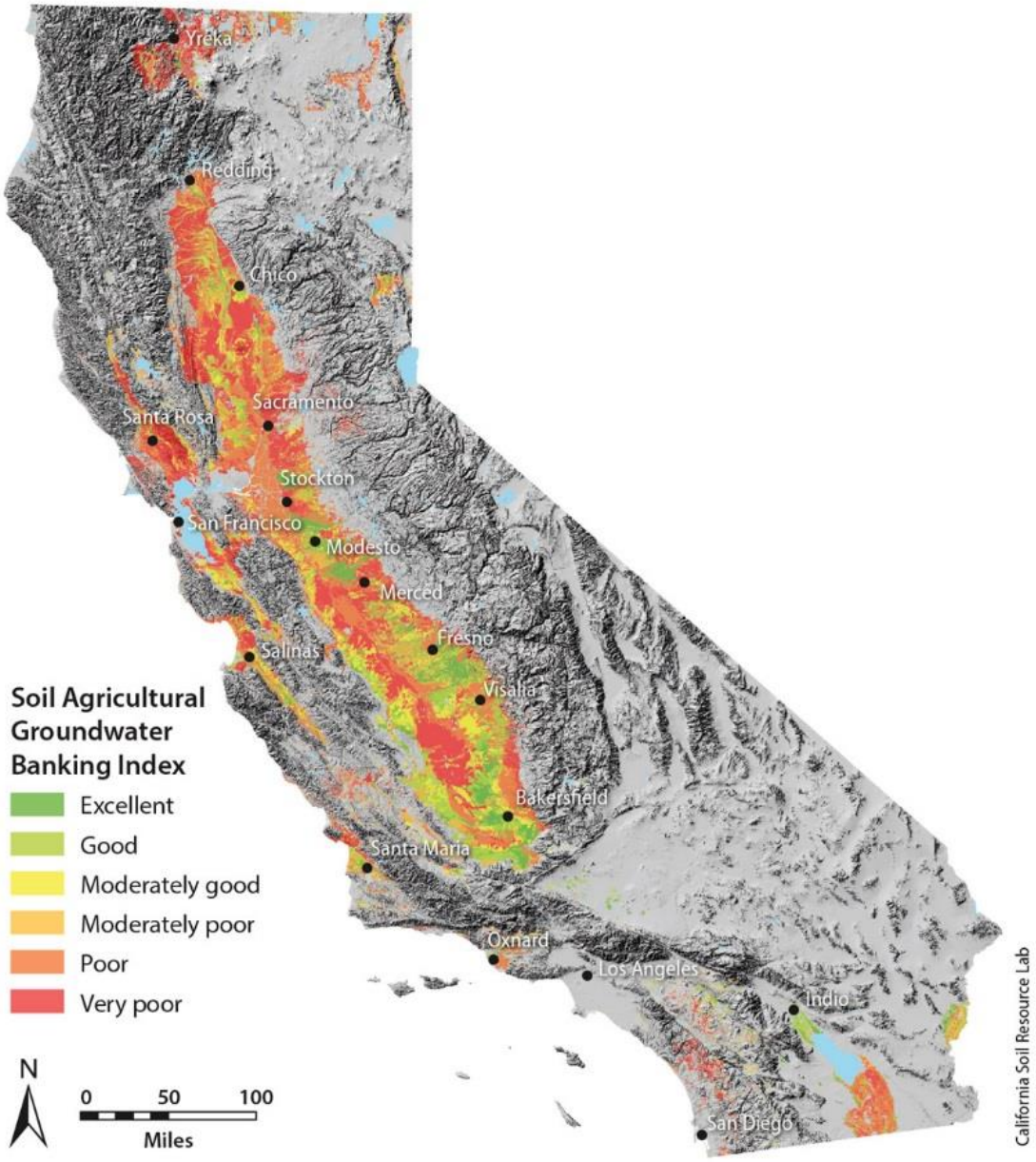

Figure A-1. Soil Agricultural Groundwater Banking Index Identifying Potential Areas for Groundwater Banking on Agricultural Lands

Source: Green, A.T. et al. 2015. California Agriculture. Soil suitability index identifies potential areas for groundwater banking on agricultural lands. Available at: http://ucanr.edu/repositoryfiles/cav6902p75-157818.pdf

ATTACHMENT B.

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